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Treatment of Municipal Sewage with Microalgae- A Laboratory based Study

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Abstract : Treatment of municipal sewage with Microalgae removes nutrients like Nitrogen, Phosphorus, Heavy metals and other impurities present in the sewage. Microalgae use the sunlight, CO_2, and impurities present in the wastewater for their growth. The present study shows the treatment of municipal sewage water with Laboratory Based Microalgae treatment System. It was observed that, the nutrients (Ammonia and Phosphate) removal efficiency of microalgae based treatment system for a 3 days batch reactor was about 85-95%. The microalgae treatment system also succeeds to remove 70-87% of COD, BOD and other impurities present in wastewater. It was observed that the microalgae treatment system is economical, green, and environmental friendly option of wastewater treatment.

Keywords: Carbon Dioxide, Microalgae, Nutrient, Reactor, Sunlight, Wastewater.

I. Introduction

Water pollution is one of the most critical environmental problems due to the increasing population and rapid industrialization (Abdel-Raouf *et al.,* 2012). For the treatment of municipal sewage water various conventional methods are used in India but they are very costly and not economical (Butler et al., 2015). Microalgae based wastewater treatment system have gained importance during the last 50-60 years and now it is widely accepted that microalgal based municipal sewage water treatment systems are as effective as conventional treatment systems (Bulent et al., 2013).

Nowadays cultivation of Microalgae in municipal sewage water for the growth of microalgae is a common treatment method for the municipal sewage water (Singh et al., 2016). It also controls pollution and produces the energy from microbial biomass of microalgae (Weiming et al., 2015). To solving some critical environmental problems like global warming, water scarcity, increase of ozone hole and climate change, microalgae based municipal sewage treatment system is one of good solution. Due to increasing population and pollution loading in surface as well as in ground water the availability of water is less, so it is important to make the water reusable by removing the nutrients, BOD, COD, toxic chemicals and other pollutants (Kumar and Goyal, 2008).

Surface waters that have been polluted from human activities like municipal sewage water use for the production of microalgae, so it provide a low cost source of nutrients such as Nitrogen, Phosphate, Minerals etc (Andre DuPont, 2012, Tang et al., 1997). Microalgal based municipal sewage water treatment systems has a two component systems one is microalgae and other is municipal sewage water, the system includes interactions between the microalgae and the municipal sewage water (Nirupama Mallick, 2002). For the treatment of municipal sewage water some important factors such as species selection, sun light, pH, effect of algal density, light intensity, temperature, etc (Pires et al., 2013, Patrick 2009, Nirupama Mallick,2002). Nutrient removal from the sewage is very important because nutrient rich effluent causes eutrophication into surface water (Al Darmaki et al., 2012, Dalrymple et al., 2013).

Microalgae based municipal sewage treatments system has a number of unique benefits such as; they do not require huge land for cultivation. In fact, microalgae cultivation facilities and treatment system can be built on a small area of land that has few other uses. The wastewater used in algae cultivation can be saline, sewage, agricultural wastewater (Matthew N Campbell, 2008).

II. Material and Methodology

A. Reactor Design

For Microalgae Cultivation and treatment systems, the various design factors to be considered like; Light source, Light/dark cycles, CO_2 supply or proper mixing, Nutrient supply (N, P, and other minerals). Two types of batch reactor were used one for cultivation of microalgae and second for treatment of municipal sewage water with microalgae. A reactor was designed with a capacity of 3 litres and glass fibre material was used. The Dimension of the reactor was 13 cm Length, 13 cm Breadth, and 26 cm Height.

B. Sampling Procedure

The microalgae sample was collected from Shubash Sarover Garden, Mora Bhagal Surat Gujarat and further cultivated in Laboratory. Municipal sewage water was collected from sewage pumping station near malhar shopping complex Ichhanath, Surat Gujarat. Grab sampling was used for sewage collection.

C. Treatment system

Municipal sewage water was used for the treatment in a batch reactor of dimensions 13 cm Length, 13 cm Breadth, and 26 cm Height for 3 days retention time in Laboratory with controlled conditions. For laboratory based treatment System 16 hr Light/ Dark ratio is provided. A halogen lamp of 500 watt was used as a light source and releases the light of intensity 2600 lx. After 3 days of treatment the treated sample was kept for 1 hour for settling of microalgae and after one hour supernatant was collected for testing. The various parameters was analysed such as, Nitrogen as NH_3, Total

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Phosphorus, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Sodium (Na^+), Potassium (K^+). All the parameter was analysed as per the Standard Methods given in APHA.

III. Results and Tables

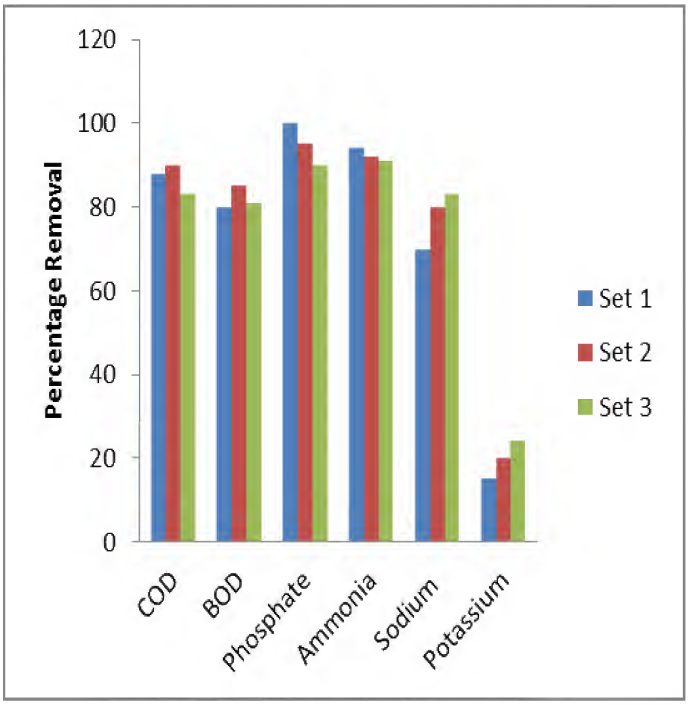
For treatment of sewage water 16 hours light and 8 hours dark condition was provided. At 16 hr L/D ratio a good removal of pollutants was observed. For light source a halogen lamp of 500 watt was used and it releases light of intensity 2600 lx.

Characteristics of Municipal Sewage water

Parameter	Initial characteristics (mg/L)
COD	215-415
BOD	165-230
Phosphate	7-18
Ammonia	26-63
Sodium	308-475
Potassium	9-13
pH	7.65-9.0

After the 3 days treatment system was able to remove about 88-90% COD, 80-85% BOD, 90-100% phosphate, 90-95% ammonia, 80-83% Sodium, and 20-25% potassium at 16 hr L/D ratio.

Percentage Removal of pollutants with microalgae



Treated sewage water characteristics

Parameter	Treated sewage water (mg/L)
COD	25-70
BOD	35-60
Phosphate	0.1-2.1
Ammonia	1.5-6
Sodium	70-200
Potassium	7-9

The COD, BOD, Phosphate, Ammonia, Sodium and potassium was reduced from initial value to 25-70 mg/L, 35-60 mg/L, 0.1-2.1 mg/l, 1.5-6 mg/L, 70-200 mg/L and 7-9 mg/L respectively. So the method of treatment of sewage water with microalgae with 16 hr L/D ratio was very efficient.

IV. Conclusion

From the present study it was observed that the microalgae based wastewater treatment system have the ability to remove nutrients, heavy metals, organic and inorganic toxic substances, BOD, COD and other impurities present in the wastewater by using the sunlight, CO_2, and impurities present in the wastewater. It observed that after 3 days the system gives good results. It can be concluded that the nutrients removal efficiency of microalgae based wastewater treatment system is very high as it removes 80-100% of Nitrogen and Phosphorus. The treatment system also succeeds to remove 40-60% of COD, BOD and other impurities present in wastewater. The study shows that the microalgae treatment system is very environmental friendly, green and economical method of sewage treatment.

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